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OF

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MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND.

No. 22 FEBRUARY, 1882. Vol. V.

I.—*Minerals New to Britain.*

By Professor Heddle.

Read December 23rd, 1880.

A NUMBER of minerals not before noticed as occurring in Britain have been described, and corroborative analyses thereof have been given, in the papers which I have, from time to time, published in the *Transactions of the Royal Society of Edinburgh*, and also, though to a smaller extent, in the *Mineralogical Magazine*.

Those which I now bring forward, have been analysed for the most part for a considerable time; but, as it must of necessity be long before I come to notice them, in their proper place, in my "Geognosy of Scotland," it is well to announce their occurrence without further delay.

Halloysite.

This was found in the Hospital Quarry, near Elgin, by Professor Nicol, and sent to me by him, as a substance which he could not recognise. As my own experience did not avail in determining it, the specimen was analysed.

Prof. Nicol obtained it in a vein of an inch and a half in thickness.

The colour is white to faint yellow, it is very soft and friable, with a minutely-granular structure.

It yielded—

Silica	39·300
Alumina	38·572
Ferric Oxide	1·428
Manganous Oxide	·250
Lime	·746
Magnesia	·833
Water	19·340
	100·469

It loses 4·626 of the above water at 212°.

This quarry was afterwards visited by Professor Nicol, Mr. Dudgeon and myself, under the guidance of Dr. Gordon, of Birnie; when the mineral was found in a very singular and interesting position.

On the north cliff of the quarry, in a now unworked portion thereof, there is a rent of about a couple of feet in width; this rent extends downward through the stratum to a greater depth than the working has been carried.

The rent has been filled to a depth of over thirty feet by boulder clay. At about five and twenty feet from the surface, we found the mineral in the boulder clay, disposed in granules, clotted-like masses and threads. There could be no question that it was a product of change.

Imbedded portions of clay-like substances, of an obscurely fissile structure,—doubtless altered fragments of schists,—were also found imbedded in the sandstone of the quarry. These, upon analysis, yielded a composition which pointed to no evident formula of expression.

Fibrolite.

I found this mineral, in small quantity, coating gneiss, in thin veins on the north-west side of Pressendye Hill, in Aberdeenshire; at about 300 yards from the summit of the hill.

Its colour was white; it was in fibrous tufts, which were very tough. No piece was got large enough for ascertaining the specific gravity.

It yielded—

Silica	39·680
Alumina	58·822
Ferrous Oxide	·038
Manganous Oxide	1·100
Potash	·860
Soda	tr.
Water	·320
	100·820

I have also found the mineral in much larger quantity, on Clashnaree Hill, in Clova, associated with *red andalusite* and *black mica;* but have failed to pick it out pure enough for analysis.

Here it is in parallel acicular crystals, which are highly lustrous, and it seemed to pass into the red andalusite.

Martite.

This was given me by Professor Archer, as having been found on the sea shore, on the north-west of the island of Bute.

The parcel consisted of rolled octahedral crystals; many of these had a red colour, and a loose and soft structure; the largest proportion, however, occurred in hard blue-black lustrous crystals, a very few of which were feebly magnetic. The majority of the crystals were entirely destitute of magnetism.

The powder was red; but in other respects the mineral seemed to be unchanged *magnetite;* the hardness and gravity being normal.

The blue-black crystals were analysed and yielded—

Ferric Oxide	97·049
Ferrous Oxide	1·096
Manganous Oxide..	·200
Lime	·952
Silica	·700
	99.997

There was no trace of titanic acid. Martite would thus appear to be in some cases merely altered magnetite.

Turgite.

This I found in isolated, imbedded, cubic crystals, in clay slate, in the Island of Kerrera, in Argyllshire; and also to the east of Oban.

These crystals have invariably a hollow in their centres: they are red-brown, and stain the hands of the same colour.

As imbedded *pyrite* occurs in the same rock, in their vicinity, they undoubtedly have resulted from its alteration.

Their specific gravity is 3·534. They yielded—

Ferric Oxide	86·585
Lime	·818
Water	5·559
Silica	7·692
	100·654

Xonaltite.

This was first found by Mr. Rose and myself, along with *gyrolite*, near Kilfinnichan, Loch Screden, Mull. More lately it was found by myself at Gribon, opposite Oronsay; and also on the north shore of Loch na Keal, in the same island.

At both of these places, it resembles a granular pink chalcedony. Its specific gravity is 2·605; it is generally associated with gyrolite, the plates of which are nearest to and radiate from the surface of the rock; they thus penetrate, as it were, the substance of the massive-looking *xonaltite*, which appears as if it had been poured over them.

It yielded—

Silica	48·910
Alumina..	·111
Ferrous Oxide	2·966
Manganous Oxide	2·270
Lime	40·385
Magnesia	·559
Potash	1·164
Soda	·222
Water	4·173
	100·760

The occurrence, as British species, of the rocks and minerals which now follow, has been before noted; but, so far as I know, no analyses of these have been published.

Schiller Spar.

I found this mineral first in the immediate neighbourhood of Aberdeen. There is to be observed in the long sand-beach which stretches from Aberdeen to Forvie Ness, at the distance of about four miles from the town, a mass of rock, which, from some fancied resemblance, has received the name of "the Black Dog." This consists of crystals of *talc*, matted in such confusion as to form both a tough and a hard rock.

A little seaward of this, there lie, impacted in the sand, and submerged at high water, two very dark masses. The three, occurring in line, point to the little Burn of the Black Dog. The banks of this burn indicate that a vein of similar material may have been lodged in it. This vein may run to the large mass of serpentine which occurs in the neighbourhood of Belhelvie, as mentioned below.

The black masses, when broken into, proved to be a mixture of a dark *serpentine*, with crystalline lumps of the mineral in question.

These crystalline lumps cleaved uniformly in one direction;—they had no trace of definite external form.

In appearance they in every way were identical with the Basta specimens,—being, however, markedly larger in the glimmering foliations.

Their specific gravity was 2·649. The portion analysed was as much as possible freed from the dark serpentinous *rods* which penetrate the mineral in so singular a manner; but, at the best, this could be effected to but a small extent. It need hardly be said that the portion chosen was one in which the green glimmering matter predominated.

The analysis was conducted on 1·092 grammes, and yielded:—

Silica	38·186
Alumina	2·178
Sesquioxide of Chromium	·276
Ferric Oxide	·028
Ferrous Oxide	8·479
Manganous Oxide	·513
Lime	2·912
Magnesia	32·418
Potash	1·401
Soda	·065
Water	14·030
	100·486

Of the Silica, 5·914 per cent was insoluble in boiling sodium carbonate.

Shortly after having discovered the mineral at this locality, it was found by Professor Nicol and myself, in two quarries which are cut into a hill-side near the farms of Craigie and White-Cairns, on the west side of the Belhelvie Hills. We were guided to these quarries, first by the blackness of the road-metalling, and then by being startled by seeing what we took for *buttons of bronze*, lying among the dark and ground-up metal of the road. These bronzy buttons proved to be slightly weathered and loose lying crystals of *schiller-spar*. Even in the quarry they are not so unaltered as those which, upon the sands at the Black Dog rock, were shut off from the air by the sea water.

Native gold has been said to occur in serpentine in this neighbourhood; the occurrence here of *pyrite* in dendritic forms, and of a surprisingly golden tint, doubtless accounts for the assertion.

It will be seen from the above analysis, that this substance is very much of the nature of a serpentine; or perhaps it would be more correct to say that it is an apparent passage of an enstatitic mineral into serpentine; like the so-called *bronzite* of Balhammie Hill, an analysis of which I have given elsewhere.

Indeed, a section of this Schiller-spar shows, under the microscope, *processes* of serpentine extending from the serpentine rods; these processes branch and anastomose, so as, in parts of the slide, almost to usurp the whole ground of the transparent mineral.

Hydrous Saussurite.

The late Mr. David Forbes has stated that Saussurite is a common mineral in Scotland. While there are certain of the massive granular *labradorites*, or mixtures of *labradorite* with *anorthite*, which bear some resemblance to the Saussurite of the Geneva blocks, I have never by analysis been able to prove the existence of true Saussurite in Scotland.

The substance which bears most resemblance to it, is an opaque, white, minutely-granular substance, which, along with large crystals of diallage, forms the "*diallage rock*" which occurs upon the shore, a little northward of Lendalfoot, in Ayrshire.

This substance has a greasy lustre, and is exceedingly tough. It has no cleavage. The specific gravity is 3·088.

Its analysis yielded:—

Silica	39·923
Alumina	27·511
Ferric Oxide	1·918
Lime	17·126
Magnesia	1·663
Potash	1·395
Soda	4·626
Water	6·124
	100·186

This looks somewhat like a hydrated Saussurite; but the following fact throws much doubt upon the correctness of such an inference.

Grey striated crystals of *anorthite* also occur in association with the diallage at the same locality. These have a specific gravity of 2·761.

Well marked crystals of this mineral yielded:—

Silica	44·224
Alumina	31·442
Ferric Oxide	1·955
Lime	14·180
Magnesia	1·000
Potash	1·480
Soda	1·625
Water	4·023—3·348
	99·929

The crystals chosen for analysis were taken as being quite apart from any contact, or mixture, with the former mineral. But, where the larger masses of the first analysed mineral occur, they are, when broken up, almost always found to contain a more translucent and distinctly-striated *centre of anorthite*,—which latter *passes by insensible gradation into the so-called Saussurite.*

This would lead to the conclusion that the sea water had effected the change; a conclusion which, however, hardly can account for the marked increase of specific gravity.

The fact of the occurrence of *Prehnite*, (a mineral with a very similar composition,) in the immediate neighbourhood, scarcely, in the present state of our knowledge, aids in explaining the relationship.

The Prehnite—(which has been analysed) and which occurs in crystals, is found to form the white bands of a highly-convoluted and much-altered schistose rock; one which, in its denser and more altered portions, somewhat simulates an igneous one.

Though the district has been examined by more than one eminent geologist, it calls for a very much more careful examination than it has received: and this examination will fall far short of perfection if it be not supported by, or based upon an extensive series of analyses. While I do not adopt Dana's view that true Saussurite is allied to *zoisite*, I also hesitate to assign the present mineral to Saussurite; and have given it the above qualified name, merely to direct attention to it, and to the interesting circumstances of its occurrence.

Tachylite.

This was found as a crust of about half-an-inch in thickness, upon the under surface of one of the beds of amygdaloid which occur in the approach to the Quiraing in Skye,—near the summit of that approach. The dolerite was itself dense and close grained. The

tachylite appeared to be the result of the fusion of the dolerite, or perhaps of its rapid chilling when first poured out; there being a passage of structure at the point of contact.

The tachylite was in parts dark-brownish-black, and it was then lustrous. More usually it was black, or pitchy brown; then its lustre was resinous. It was much fissured, and had a conchoidal fracture.

Its specific gravity was 2·68. It yielded—

Silica	45·615
Alumina	14·423
Ferric Oxide	4·927
Ferrous Oxide	9·411
Manganous Oxide	·153
Lime	8·098
Magnesia	4·000
Potash	2·397
Soda	4·186
Water	6·830
	100·090

Loses 1·834 of the above water at 212°. It fuses readily, with sodium re-action, to a lustrous black glass; the rock does the same; and fused portions of the rock are very similar to the tachylite.

The Dolerite.

To ascertain what change had been induced in the rock itself through its conversion into tachylite,—or if, in fact, tachylite was but a fused dolerite,—a portion of the latter, broken at a distance of about five inches from the tachylite crust, was analysed.

This portion was hardly a typical piece of the general mass of the rock, being denser in structure; that is, it did not show the crystalline constituents well:—it also appeared to be slightly weathered.

It yielded—

Silica	46·423
Alumina	14·010
Ferric Oxide	5·027
Ferrous Oxide	9·022
Manganous Oxide	n. d.
Lime	8·104
Magnesia	3·820
Potash	2·000
Soda	3·820
Water	7·222
	99·448

The change is thus very slight. The portion which has fused is slightly more alkaline; and, from its retention of water, it must have liquified under great pressure.

Pitchstone.

From Corrieghil, Arran. This is the dark brown-black *pitchstone* which, with imbedded transparent crystals of colourless *sanidine*, forms the well known and beautiful porphyry of this locality.

It yielded—

Silica	72·066
Alumina	11·263
Ferric Oxide	3·237
Manganous Oxide	·002
Lime	1·530
Magnesia	·003
Potash	5·612
Soda	·605
Water	5·449
	99·767

Spherulite.

From the pitchstone of Corrieghil, Arran. It occurs in the paler green varieties of the pitchstone. Where this weathers, it exhibits a spherical structure on its surface; which seems to show that the spherical portions of the rocks are less soluble in water, than the amorphous. When broken, the imbedded spherules are seen to have a radiated structure, cinctured now and again with one which is concentric. The concentric bands are sometimes white and powdery.

Silica	77·230
Alumina	10·440
Ferric Oxide	1·867
Manganous Oxide	·538
Lime	·904
Potash	5·740
Soda	2·225
Water	1·186
	100·130

It loses ·342 per cent. of water at 212°. Taking into consideration this larger proportion of silica,—along with the radiating structure and its more sparing solubility, it would appear that this is a pitchstone which contains bundles of radiating crystals of quartz, or perchance *tridymite*.

Paulite.

"*Hypersthene*" has, or rather *had* been for long considered to occur among the Coolin Hills of Skye.

My analyses of specimens, furnished by those who most strongly maintained its existence there,—which analyses were published in the *Transactions of the Royal Society of Edinburgh*,*—proved that the mineral supposed to be hypersthene, was *augite*.

The mineral had, however, been said also to occur in the neighbourhood of Portsoy, in Banffshire. This I find by analysis to be correct. It occurs, somewhat ill-defined, in some veins or beds,—it is difficult to say which,—of diorite, on the west shore of the East Bay of Portsoy. But, in company with Mr. Peyton, I have found it to occur in much finer specimens in the loose masses of a wasted outcrop, on the west side of Craig Buroch, in the same county; while again Mr. Peyton had himself previously found it, in still finer specimens, south of the farmhouse of Retannach, in the same neighbourhood. Here also it occurred in loose blocks. The blocks on Craig Buroch lie in line, and indicate the weathered outcrop of a bed.

In these blocks it occurs in what are probably exfiltration-veins; and its immediate associates are, striated grey *labradorite*, massive *iserine*, *pyrite*, and an *augite*, which much resembles *enstatite*.

The colour of the Paulite is bronzy, with a shade of red-purple on one cleavage; it is black and lustreless at right angles to this. The cleavage was as figured—*b* being the lustrous face; *a* the black. It had a lustre quite as brilliant as have the Newfoundland specimens. Its specific gravity is 3·32; its powder is light-brown.

1·3 grammes yielded—

Silica	51·461
Ferric Oxide	4·022
Ferrous Oxide	12·673
Manganous Oxide	·692
Lime	5·299
Magnesia	24·230
Potash	·252
Soda	·741
Water	·519
	99·889

It loses at 212°, ·436 per cent. of water.

* Vol. XXVIII, p. 478.

The *Paulite* both of Retannach and of the East Bay of Portsoy, seems to pass into the glassy bottle-green enstatite-like variety of augite. I considered this bottle-green mineral to be enstatite until it was analysed. Its analysis is published in the *Transactions of the Royal Society of Edinburgh, Vol. XXVIII, p.* 465.

In polished slabs of the rock from Portsoy, the bronzy flash of Paulite is seen surrounding the translucent green mineral like a fringe. Sections of the Retannach augite, again, are bronzy in spots; and these spots the microscope shows to be "shot" more or less profusely by the characteristic flattened-tube structure of the Paulite.

Zoisite.

This has been stated by Jameson to occur at Glenelg. From its occurrence at several other limestone localities in Scotland, this is far from improbable; but I have not myself, during several visits, succeeded in finding it there.

A specimen moreover, from this locality, which was given to me for analysis by Principal Forbes, as Jameson's Zoisite, proved to be scalacolite; it was in a lanceolate form, one in which I have there found that mineral in abundance.

1. I first found Zoisite in Scotland in a quartzose bed in the limestone at Gartally, in Glen Urquhart. It occurs in colourless and grey crystals, imbedded either in horny quartz, or in the lime itself.

Its specific gravity is 3·014. It yielded

Silica	39·600
Alumina..	31·083
Ferrous Oxide	2·071
Manganous Oxide	·078
Lime	23·336
Magnesia	tr.
Potash	·566
Soda	1·056
Water	2·412
	100·202

2. This specimen was given me by Professor Geikie. It was got a limestone quarry on a hill side about half-a-mile west of Laggan, Tulnan Bridge, near Grantown, Invernesshire.

It here occurs in pale brown crystals imbedded in a bed of translucent, but muddy quartz. On visiting the locality, I found that it is associated immediately with *chlorite*, *sahlite*, *Biotite*, and other minerals occuring in limestone. In the near neighbourhood are found *kyanite*, also small quantities of *galena* and *blende*.

The specific gravity of the Zoisite is 3·438. It yielded—

Silica	38·750
Alumina..	28·144
Ferric Oxide	6·547
Manganous Oxide	·916
Lime	22·026
Magnesia	·416
Water	3·333
	100·132

It loses ·155 per cent. of moisture at 212.°

Idocrase.

The specimen analysed was part of a magnificent dark-brown crystal of nearly seven inches in length by one in thickness,—unfortunately broken in the extraction, or rather in the discovery,—which was got in the limestone quarry of Dalnabo, in Glengairn, Aberdeenshire.

Its specific gravity is 3·43. There was obtained—

Silica	36·251
Alumina..	18·626
Ferric Oxide	·932
Ferrous Oxide	5·036
Manganous Oxide..	·844
Lime	33·935
Magnesia	1·574
Potash	·568
Soda	·529
Water	1·780
	99·875

The Idocrase is associated with so large a number of minerals that it is a source of great regret that the quarry is no longer worked.

Andalusite.

Red andalusite—formerly called "red schorl," has for long been known as occurring in Aberdeenshire; and Achindoir has been given as the locality.

The late Rev. Mr. Morgan, of Stonehaven, undoubtedly found the locality; but he kept it a close secret. It took the writer many wanderings, during part of three summers, before he found the place.

This is the southern slopes of the hill of Clashnaree in Clova;—and also in small amount on the south side of the Peat Hill.

The specimens all lie loose; being fragments of veins which have endured, after the disintegration of a very micaceous gneiss.

The mineral very rarely is crystallised in distinct forms; being frequently bacillary. Its associates are *labradorite*, *fibrolite*, and an ill-defined *black mica*.

Its colour is a dull but uniform red;—occasionally the central core is purple.

Its specific gravity is 3·121.

The analysis, on 1·302 grammes, yielded

Silica	36·712
Alumina..	59·678
Ferric Oxide	2·302
Manganous Oxide	·230
Lime	·860
Magnesia	tr.
Water	·465
	100·247

Not unfrequently it passes directly into fibrous white *fibrolite*.

2. This variety was found in the banks of the stream, near the Mill of Auchintoul, Kinnairdy Castle, Marnoch, Banffshire.

It occurs in imbedded crystals of half-an-inch in length, along with small twin crystals of brown *grenatite*: the matrix is a scaly micaceous schist. Specks of magnetite are also present. Water-friction having removed the more friable mica, the imbedded crystals are frequently left protruding. The crystals are ash-grey; of a vitreous lustre; and hardly touched by the knife; in parts not at all so. They contain, imbedded in their mass, apparently only a minute quantity of the matrix. The angle of the crystals is *near* a right angle.

There was obtained, from very carefully picked crystals—

Silica	52·538
Alumina..	39·314
Ferric Oxide	1·094
Ferrous Oxide	3·267
Manganous Oxide	·461
Lime	·861
Magnesia	·846.
Alkalies	tr.
Water	1·110
	99·491

It is thus evident that much of the matrix pervades these crystals throughout.

This locality was found by the Rev. Mr. Peyton.

The bed of schist which carries these crystals is seen, to the northward a little east of the village of White Mills; it courses up the country southward to the Coreen Hill, near Lumsden in Aberdeenshire. In Marnoch the rock has been used for mill-stones; at Lumsden it is utilised for pavements. The intensely hard crystals of andalusite in both cases, protrude from the general surface of the stone; they act in the first case as grinding teeth; in the second, they admirably prevent slipping.

Besides the bed which crops out on the shore near White Mills, other smaller ones are seen along the same shore; some of these—notably one near Banff—exhibit small concretions of a colour either darker or lighter than the general mass of the rock; and, as many of the crystals in the Clova district have a form as undefined or ill-defined as these concretions, I incline to regard the latter as being probably an interrupted stage in the formation of the crystals of the mineral.

The analysis would indicate that nowhere in this district has the crystalline force succeeded in absolutely excluding the rock matrix, though there is not here, or at least in this deposit, that definiteness in the mode of its exclusion, or rather *extrusion*, which produces *chiastolite*. *That* mineral however occurs in a bed of clay slate, a little west of Portsoy. It should also be noted that most of the crystals at White Mills, are converted into a steatitic material of a purple colour; the varying depth of which exhibits the *chiastolite*

arrangement of particles: so that it may be said that in this district, both the *segregatory formation*, and the *decay* of this mineral is to be seen.

At the head of Glen Creran on its west side, in Glen Nevis, and near Cuil Bay, in Appin, I have also seen a rock which seems to contain incipient crystallisations of andalusite.

Withamite.

From Glencoe. The specimens, before the picking, showed minute traces of quartz, and sometimes a surrounding layer of a white dull substance; this was thought by Allan to be *Saussurite*.

The associated minerals were *green epidote*, a granular green mineral like *chlorite*, but which was probably *Delessite*, silky colourless *byssolite*, and, in the near neighbourhood, a single specimen of *Wavellite* was found.

The picking was executed with the most extreme care,—only crystalline portions being taken.

There was got—

Silica	43·230
Alumina..	23·090
Ferric Oxide	6·675
Ferrous Oxide	1·131
Manganous Oxide..	·138
Lime	20·003
Magnesia	·884
Potash	·962
Soda	·935
Lithia	·253
Water	2·400
	99·701

This does not agree over well with epidote, to which *Withamite* is always assigned; but the measured angles of the crystals leave little doubt as to its being a variety of that mineral. It is strongely dichroic; showing carmine, and straw yellow.

Olivine.

From columnar basalt at Shooter's point, Elie, Fife.

It occurs in large imbedded masses—a couple of inches in diameter,—associated with *pyrope*.

These masses are sometimes rudely crystalline; they are much fissured, of a vitreous lustre, and an apple green colour.

The specific gravity is 3·327. I obtained—

Silica	42·615
Alumina	3·154
Ferric Oxide	2·965
Ferrous Oxide	6·261
Manganous Oxide	·230
Lime	4·436
Magnesia	36·692
Potash	1·072
Soda	1·483
Water	1·164
	100·072

2. Was found near the summit of Halival, and more rarely on Hæskheval in Rum.

It occurs in badly developed crystals, in the "augite rock," along with glassy green *augite* and *labradorite*. The colour is yellow, and slightly brownish. The lustre is vitreous. Frequently there is slight decomposition, the much flawed crystals becoming powdery and dull. The powder is earthy, and of much the same colour as the unaltered mineral.

The crystals are sometimes imbedded in those of the augite,—more commonly they lie side by side. Their general appearance is somewhat like that of chondrodite.

They yielded—

Silica	38·006
Alumina	·286
Ferric Oxide	2·933
Ferrous Oxide	18·703
Manganous Oxide	·100
Lime	·336
Magnesia	38·000
Water	1·587
	99·945

The specimen analysed was not *absolutely* free from the powdery portion: the ferric oxide may represent the change to some extent. That change in no way resembled a passage into serpentine: indeed it has to be remarked that the mineral itself does not resemble olivine while the associated glassy augite very much resembles it.

Pinite.

This mineral has been noted by Dr. Macculloch as occurring in certain porphyries which cut the quartzite of the Cairnwell hills in Perthshire; he also notes it as actually imbedded in quartzite, west of Ben y Gloe. I will not say that the mineral he observed was not something of this nature:—it is in small six-sided prisms,—but these are distinctly foliated, and they always appeared to me more like a black mica which was somewhat decomposed.

I have myself noticed a substance very similar to these crystals, and which bore much more resemblance to *pinite*, in the red porphyry which is interstratified with the quartzite of Canisp, in Sutherland.

The substance I at present note, however, is not to be mistaken,—though its colour is somewhat unusual for pinite. It occurs imbedded in micaceous gneiss in the banks of a stream—the Burn of Craig,—on the north-east slopes of the Buck of the Cabrach, in Aberdeenshire. It is associated with *Biotite* (*or* lepidomelane).

It is crystallised in prisms of about an inch in width, and passes into *chlorophyllite*; its colour is asparagus green, it is transparent, and of vitreous lustre. Its appearance is intermediate between *apatite* and *beryl;* and it is altogether very gem like.

Its specific gravity is 2·911. ·98 grammes yielded—

Silica	41·224
Alumina	28·498
Ferric Oxide	·156
Ferrous Oxide	5·484
Manganous Oxide	·102
Lime	·914
Magnesia	6·612
Potash	10·367
Soda	·953
Water	5·670
	99·980

Of the silica only ·198 per cent. were insoluble in sodium carbonate solution.

Gigantolite.

This was first given me by the Revd. Mr. Peters, of Deer, through Mr. Alexander Cruickshank, as from Torry, Aberdeen. In 1877 it was obtained by myself, along with the last named gentleman and Professor Nicol,—in a granitic vein, a little east of the remains of the old breakwater at Torry. I was associated with *Davidsonite* (beryl) *specular iron, muscovite* and *tourmaline.*

The *gigantolite* or *iberite* occurs in crystals of an inch in width, by two in length; the form is generally obscure, having frequently as much resemblance to that of tourmaline as to *iolite*. The colour at the deeper-seated end is dark green; the structure minutely foliated and dense. At the other extremity of the crystals, the material is almost wholly apparently *muscovite;* arranged as a matted mass of somewhat loosely-coherent crystals.

The specific gravity of the dark dense substance analysed, was 2·898. 1·3 grammes yielded—

Silica	41·307
Alumina	28·709
Ferric Oxide	14·175
Manganous Oxide	1·000
Lime	·473
Magnesia	2·615
Potash	6·560
Soda	1·642
Water	4·250
	100·231

The possible impurity here was *mica*.

Chlorophyllite.

I found this in a deep cutting in the banks of the head-stream of the Burn of Craig, about one mile north-east of the Buck of the Cabrach, in Aberdeenshire. It was associated with *Lepidomelane* (?), and it contained, in the centre of some of its crystals, unaltered *pinite*. It was in crystals of an inch in size. Its colour was green, slightly brownish in parts; lustre somewhat pearly; opaque; it was softer than the pinite. It was precisely similar to the American *chlorophyllite*. Specific gravity 2·715.

Silica	41·266
Alumina	28·881
Ferrous Oxide	5·207
Manganous Oxide	·333
Lime	·858
Magnesia	6·633
Potash	10·083
Soda	1·406
Water	5·812
	100·479

There is thus very little difference between it and the *pinite* which it enveloped, and of which it seemed to be but an alteration product.

Scapolite.

Many years ago, while compiling his work on British Minerals, Greg wrote to me, expressing his surprise that a mineral so common elsewhere as scapolite, had never been found in Britain.

Some time after this Dr. Lauder Lindsay reported on the occurrence of a crystallised scapolite, in association with a hornblendic mineral, near lime, in the vicinity of Loch Callater, in Aberdeenshire. These crystals, however, on examination proved to be malacolite.

Again, in a report on the Granites of Donegal, submitted to the British Association by Mr. Robert H. Scott, Sir R. Griffith, and the Rev. Dr. Haughton, it is stated that in almost all the limestone localities, they found a peculiar rock, which, from the great abundance of that substance, they turned "sphene rock." "It consists of orthoclase, green pyroxene, and quartz; and in it we have discovered minute crystals of blue apatite; and in one locality (Glenleheen) a great abundance of white Scapolite." The precise locality is afterwards stated to be the cross roads, in Glenleheen; and it is also stated to occur at Tirlyn. Mr. Scott has kindly forwarded to me a specimen of the Glenleheen mineral, with the remark, "on a closer examination I think it is like a felspar."

The specimen consists of crystals of over half an inch in size, imbedded singly in quartz. These crystals have a rectangular section, and almost a pearly lustre. They are cream coloured, with a cleavage which is at least *nearly* a right angle. Here and there they seem to be striated. They have much the look of a felspar; but the fact that some of the imbedded rectangular crystals present a lustrous cleavage face, which is *also* apparently nearly at right angles *to the other two*, must throw doubt upon this conclusion.

Having no authority to detach any portion for measurement or examination, I am able to say no more than that these crystals cannot be *scapolite*, and in general appearance much resemble *albite*.

It is only within the last few years that I have found this mineral in Scotland; and on both of the occasions in which I have done so, it was a "chance find."

1. Making a habit of examining fully, and, if there be a sufficiency, analysing every substance which I am unable satisfactorily to recog-

nise, I set apart for examination a rough crystal, which I worked ou of the limestone which occurs about a mile north-east of Milltown in Glen Urquhart, Rosshire.

This rough crystal was imbedded among the *Zoisite* which is ther found. It occurred in what I am unable to designate more precisel than *the central of the many quarries* which have been opened in th highly convoluted stratum of limestone.

It was a greyish coloured translucent crystal; and, being imbedded no form could be made out. It was separated from the *zoisite* an set apart for examination, on account of its being of a greyer tint and was suspected to be *andesine*,—*scapolite* not having been thought o

It was very slightly mixed with pale-green *actynolite*,—say $\frac{1}{200}$th part;—and this may not have been absolutely separated from th portion analysed. Its specific gravity is 3·004.

Quantity analysed 1·305 grammes.

Silica	45·900
Alumina	27·369
Ferric Oxide	tr.
Ferrous Oxide	2·954
Lime	20·211
Magnesia	·306
Potash	·315
Soda	·582
Water	2·089
	99·728

4·34 per cent. of the silica was insoluble in boiling sodium carbonate.

I know not whether to rank this with *scapolite* or with *paranthine*.

2. In dissolving the Tiree marble, in order to obtain the *tireeite* described in a late number of the Magazine, I obtained a very larg quantity of crystals of *sahlite*. From out of many pounds of thes crystals, I picked about 100 grains of fairly-well developed crysta of a pure white, and pinkish-white mineral. Though the angl of the secrystals were,—like those of the *sahlite* and *sphene*, whi occur in this limestone,—rounded, yet the form of *scapolite* was easi made out. The square prism had its lateral angles truncated;—an there was a four-sided pyramid. The crystals were of the size large shot. The only other substance which accompanied the crystals was *talc*, in minute flakes.

1·3 grammes yielded.

Silica	48·923
Alumina	22·098
Ferric Oxide	3·159
Ferrous Oxide	1·508
Manganous Oxide	·538
Lime	7·753
Magnesia	2·769
Potash	6·058
Soda	1·279
Water	5·694
	99·779

Loses at 212°, ·972 per cent. of water. 2·358 per cent. of the silica was insoluble in boiling solution of sodium-carbonate.

Pyrrhotite.

From a limestone quarry about 200 yards south-west of Fiermore, south of Tullich Hill, Blair Athole. Occurs in lumps in the vein-stone of the lime, associated with *chlorite*, *sphene* and *ilmenite*.

I obtained:

Sulphur	38·544
Iron	60·300
Silica	·153
Carbonate of lime	1·538
	100·695

Though the lime is here given as in combination with carbonic acid, as the probable form of combination, yet not the smallest trace of effervescence could be seen when acid was added to the crushed mineral.

Pyromorphite.

The specimen examined was the bright orange, or so called "chromo-phosphate of lead," from Leadhills. It was in well developed hexagonal crystals,—quite free from matrix or any impurity.

There was obtained:

Phosphate of Lead	89·038
Chloride of Lead	10·477
Phosphate of Iron	·447
	99·892

The colour would seem to be due to phosphate of iron: there was not a trace of chromium.

Aragonite.

From Leadhills. *Strontianite* has been said to occur at Leadhills: Walker mentions this as a locality. The substance analysed was purchased in Jameson Torry's collection; and was named "Strontianite, Leadhills."

It could not be distinguished from green strontianite even under the lens: perhaps the radiating crystals were somewhat more glassy in lustre, and slightly more transparent.

I obtained:—

Carbonate of lime	96·430
Carbonate of strontia	1·730
Potash	·593
Soda	1·095
Water	·345
	100·193

This is a most singular result. The amount of carbonic acid obtained was sufficient merely to saturate the lime and strontia; still it is altogether inconceivable that the alkalies existed free.

Pale-green aragonite in small brushes of crystals, has recently been got at Leadhills; but this has no resemblance to strontianite.

Reddle.

This was found in imbedded nodules, in sandstone in Newton Quarry, near Elgin. It was soft and clay-like when damp; powdery when dry; colour deep and bright-red.

It yielded:—

Silica	55·746
Alumina	17·253
Ferric Oxide	8·263
Ferrous Oxide	1·655
Manganous Oxide	·278
Lime	·567
Magnesia	2·481
Potash	5·590
Soda	1·400
Water	6·550
	99·783

Lydian Stone.

Occurs in the volcanic "necks" to the east of Kinkell, Fife; partly as volcanic bombs, consisting of perfectly formed Lydian stone: partly coating imbedded masses of altered shale, from which it had evidently been formed.

The shale in the centre of these masses, which are sometimes a foot or two in diameter, is much split up in the lines of its cleavage and cross-cleavage. The cleavages disappear when it passes into the vitreous Lydian stone, with conchoidal fracture.

The bombs are smaller, being rarely over half a foot in size. They are dense, conchoidal in the fracture, deep blue in colour; forming an excellent touchstone. The specific gravity is 2·598.

Silica	61·200
Alumina	17·536
Ferric Oxide	3·163
Ferrous Oxide	5·446
Manganous Oxide	·900
Lime	3·136
Magnesia	2·700
Water	5·889
	99·97

It loses 1·011 per cent. of water at 212°.

Hornstone.

This somewhat chalcedonic variety occurs in the clinkstone quarry on the north-east side of Blackford Hill, Edinburghshire.

The colour is brown; the mineral is translucent, but dull in lustre. It sometimes has a quartzy centre. Its specific gravity is 2·598.

It yielded—

Silica	89·692
Alumina	·974
Ferrous Oxide	1·373
Manganous Oxide	tr.
Lime	2·283
Potash	·540
Soda	2·271
Water	2·773
	99·906

Loses ·624 per cent. of the water, at 212°.

Chert.

This occurs in veins of two inches in thickness, cutting the veinstone of the Fee Donald mine at Strontian, in Argyllshire. Its colour is pale emerald green; its structure is minutely granular; it has sometimes a colourless massive-granular centre; sometimes a quartzy centre. It contains imbedded cubes of *galena*.

It yielded—

Silica	89·692
Alumina	·769
Ferrous Oxide	1·671
Manganous Oxide	·076
Lime	2·843
Potash	·440
Soda	2·180
Water	2·005
	99·676

Loses ·22 per cent. of the water, at 212°.

Lignite.

Was taken from a bed which was under the "Organ," at the Giant's Causeway. This bed was overlaid by a bed of *plynthite*, which sometimes contained nests of augitic-glass.

It was underlaid by the "shale," an analysis of which follows.

The *lignite* showed the structure of dicotyledonous wood. In part it was dull-brown and woody,—this had a specific gravity of 1·36. Other parts were dense black, and like cherry coal; both were analysed.

	Lignite.	Cherry Coal.
Gas	42·41	38·02
Volatile at 240°	4·44	
Carbon, residual	40·05	51·16
Water	7·18	7·72
Ash	5·92	3·10

The *shale* was of a black colour; it gave off no *inflammable* gas; and left a brown ash.

Gas	14·82
Carbon	4·23
Water	10·06
Ash	70·89

Ozokerite.

This name has been vaguely applied to substances which have not been analysed.

The substance to which I apply it has been found, for many years, at Binny quarry, in Linlithgowshire. I have got lumps of it of half the size of a man's head. These have a rudely-foliated structure; a clove-brown colour, yellowish in thin portions; and they show an unmistakable fluorescence. It is brittle, easily cut, and very soft. It has a greasy to a waxy lustre, and a greenish reflection. Specific gravity 961. 30·4 grains were analysed—

Naphtha, which has an odour of elastic bitumen, volatile at 205°	·691
Gas	96·974
"Free" Carbon	2·039
Ash	·372
	100·031

The ash was in thin brown shreds, somewhat like withered leaves. The miners melt this substance up with tallow, and mould it into candles; these are nearly black in colour, and, from choking of the wick, burn very badly: there is also much carbon deposited from the flame.

II.—*On some Ill-determined Minerals.*

By Professor Heddle.

Read December 23rd, 1880.

THE following substances have, for the most part, passed under the names here assigned to them; but they are themselves either ill-determined, or doubtful species: in some cases the name has been attached to certainly more than one specifically-distinct substance.

Plynthite.

From Quiraing in Skye. It occurs in layers of an inch or two in thickness, among the amygdaloids. It is usually of a deep-red colour and has a greasy lustre, but is sometimes earthy and dull.

It falls to pieces in water, and may, by this property, and its uniform dense structure, be distinguished from the red *massive mesolite* which sometimes occurs along with it.

It yielded—

Silica	29·547
Alumina	19·027
Ferric Oxide	28·013
Ferrous Oxide	3·251
Manganous Oxide	·844
Lime	2·234
Water	17·391
	100·307

It loses 6·687 per cent of moisture, at 212°.

At the Storr in Skye it occurs in a *repeated series* of beds. It is evidently merely *bole*, and probably has resulted from *a bed of earth* which has been covered, and burnt by a trap stream.

Uigite.

Noticing in an old number of the Mineralogical Magazine a query as to *uigite*, it came to my recollection, that my description and analysis of this substance had possibly never appeared in a scientific journal, except

in the Ed. N. Phil. Journ. II, iv., p. 162. I therefore give an extract from a notice of it, which appeared in the "Witness" newspaper of 12th March, 1856.

"Sixteen miles north of Portree, in Skye, lies the "farm town" of Uig. At about the fifteenth mile-stone, the road makes an abrupt turn to the east, before descending the hill; and just at this spot a small quarry has been opened for the purpose of obtaining road-metal. In this quarry I obtained indifferent specimens of *faröelite*, a single crystal of *analcime*, and a few pieces of a substance which, being unknown to me, I analysed, and which may be considered new. Should this be admitted, I would propose for it the name *uigite*. It occurs in small nests in the amygdaloid, which is here very vesicular, is not distinctly crystallized, being in radiated sheafy plates, somewhat resembling the structure of a plumose mica, but in general appearance is intermediate between *faröelite* and *gyrolite*; colour white, slightly yellowish; lustre tremulous and pearly; hardness, 5·5; brittle; specific gravity, 2·284; before the blow-pipe fuses readily and quietly, with strong re-action of soda, to a white opaque enamel, which is not frothy. On analysis it afforded on two occasions.

Silica	46·320	45·980
Alumina	21·348	21·928
Lime	16·361	16·150
Soda	4·698	4·685
Water	12·212	11·250
	100·939	99·993

These proportions give equivalents,—silica, 7; alumina, 3; lime, 4; soda, 1; water, 9. The mineral, therefore, consists of 1 equivalent of a silicate of lime and soda (where the lime is to the soda as 4 to 1), 1 equivalent of a sesquisilicate of alumina, and 9 of water. The calculated percentage proportions of which compound are,—silica, 46·09; alumina, 21·93; lime 15·97; soda, 4·46; water, 11·55; which percentages agree closely with the analytical results. No mineral has the above formula, which differs, however, from that of *faröelite* (mesole), merely in the insertion of the compound $2(CaO, SiO_3)+H.O$. We have now to see whether it is not a compound mineral, *i. e.*, a combination of two minerals; as its composition is capable of expression by a rational formula, the substance cannot be a *mixture*.) For this purpose, let us look for an instant at gyrolite, the new mineral lately discovered by Dr. Anderson, in Skye. That chemist gives $2(CaO,SiO_3) + 3\ H\ O$, as the formula of gyrolite, which requires 15·40 per cent of water, but admits that the mineral readily loses water, and that none but specimens newly broken from the rock

contain so large a quantity. While I myself am strongly inclined to think that even fresh specimens have an atom less of water, yet I am not at present prepared definitely to say so; but I am prepared to assert that the specimens of gyrolite ordinarily procurable, and such as are to be found in cabinets, have more probably the formula $2(Ca\ O, Si\ O_3) + H\ O$;—as I have obtained many such percentage proportions of water as the following:—6·417; 5·98; 6·83, &c.:—the last given formula requires 5·72. Gyrolite would thus seem to be a mineral which, like *Lomontite*, loses a certain quantity of water at once on the very exposure to the air; and, like *Lomontite*, this loss is accompanied with other changes—as of form, colour, lustre, &c.; for, when fresh, *gyrolite* is colourless, transparent, of a vitreous lustre, and tough; after a short exposure it becomes white, opaque, of a pearly lustre, and crumbles readily. Now, this latter formula of gyrolite is the very compound which we have to add to the formula of faröelite, to convert it into the formula of *uigite*,—as before shown. Three equivalents of *faröelite* united with one of *gyrolite* will give a compound agreeing closely with the analysis of *uigite* and giving the same formula. I have already noticed that in appearance *uigite* stands intermediate between the above minerals. Under this consideration of the subject, therefore, *uigite* is made up of three equivalents of *faröelite*, and one of *gyrolite*; if we are not allowed to consider *gyrolite* as having ordinarily the above formula, then *uigite* must stand as a *simple* and not a *compound* mineral. I do not, however, dogmatically thrust it into the world as a new mineral; but, waiting for more information, would merely make a note that such a compound as I have described is to be found at Uig, in Skye."

In consequence of the modern reading of the composition of silica, the above formulæ have to be altered.

Ferrite.

This was sent to me by Mr. John Young, of Glasgow, as the *ferrite* of the late Wallace Young.

It was first given me, however, by the late Dr. Thomas Brown, of Lanfine, as "a new mineral." Dr. Brown's specimens,—which are identical in appearance, though hardly so well marked as Mr. Young's,—were from the neighbourhood of Kilpatrick.

Mr. John Young's specimens were from the Gleniffar Braes. The mineral occurs in crystals, imbedded in an altered dolerite. The crystals are deep red to chocolate brown in colour; they have two cleavages, which are both lustrous. They are easily broken, or rather split, along the cleavage faces; and they are so soft as to be bruised by the nail.

Subjoined is its analysis, tabulated as obtained after heating in the water-bath, and also in its ordinary state.

	DRY.	ORDINARY.
Silica	13·544	13·025
Alumina	13·684	13·160
Ferric Oxide	55·600	53·473
Ferrous Oxide	4·691	4·511
Manganous Oxide	·154	·148
Lime	·780	·750
Magnesia	6·888	6·624
Water	4·744	8·394
	100·085	100·085

The mineral was found to lose 3·832 per cent. of water at 212°; and, as it was analysed by Wallace Young, *after having been dried at* 212°, the calculated percentages in the dry condition have been given in the first column, in order to compare them with the analysis of Mr. Young.

Mr. Young got in his analysis, 9·53 per cent. of *mixed quartz*;—deducting this, and adding 3·832 p.c. of water, to bring the constitution up to that of the mineral *in its ordinary state in nature*, we get the percentages in the second column, by calculation from the first.

Young's Analysis.

	DRY.	ORDINARY.
Silica *quartz*	9·53	
Silica	11·80	12·539
Ferric Oxide	68·93	73·272
Magnesia	5·26	5·591
Water	4·66	8·778
	100·18	100·18

At the first glance this appears a very different result from mine; but if it be supposed—which is far from impossible—that, in presence of the high colour of the precipitate obtained by ammonia, Mr. Young did not suspect alumina, and that he did not separately estimate the *ferrous* oxide—which at the date of his analysis was hardly ever done—but weighed and estimated the whole ammonia-precipitate as *ferric oxide*, the two analyses will be found to be really close.

My own analysis *tabulated in such a form*, is given as under 1; Mr. Young's as 2.

	1	2
Silica	13·025	12·539
Ammonia precipitate	71·793	73·272
Lime	·750	
Magnesia	6·624	5·591
Water	8·394	8·778
	100·085	100·18

There can thus be no question that *the same substance* was analysed; and that the mineral is an alteration-product of either *augite* or *olivine;* indeed Mr. Young has sent me unaltered specimens of rock, containing imbedded and unchanged crystals of both of these minerals. Ferrite seems therefore to have a doubtful claim to rank as a mineral, or to be, at most, a pseudomorph.

Craigtonite.

Stains, dendrites, and thin filmy coatings on rocks, are very frequently pronounced to be "manganese" or manganesian; if these have a brown or even a blue colour.

I have qualitatively ascertained that this they sometimes, are,—to the extent at least of *containing* manganese; especially such as are seen in rifts of Old Red Sandstone. Only once however have I got a sufficiency to make anything approaching to a quantitative analysis. This single instance was a thin coating which adheres to red granite in the upper quarry of Craigton, Hill of Fare, Aberdeenshire. Its colour is blue-black; here and there it has a lustre like graphite; it cuts with the knife.

There being too small an amount to admit of its being picked it was dissolved off the granite by very weak hydrochloric acid. The acid seemed hardly to affect the *lepidomelane* present, and the granite seemed altogether unaffected. In addition to the lepidomelane, the granite contains only *orthoclase* and *quartz.*

The analysis of the solution gave—

Alumina	32·203
Ferric Oxide	38·305
Manganous Oxide	7·458
Magnesia	16·610
Potash	4·745
Soda	·678
Silica	tr.
	99·999

As chlorine was evolved during the solution, the manganese must have been partly at least in the state Mn_3O_4.

I make no attempt to reduce this composition to any formula; and have given it a name merely as a nucleus to other analyses of the same or similar substances.

Ellonite.

This is an *ad-interim* name given to a pale dull yellow, somewhat unctuous powder, which I got out of small nests, occurring rarely in perfectly fresh recently blasted gneiss.

It was from a quarry about half a mile west of the railway station at llon, in Aberdeenshire. The associated minerals, which were perfectly naltered, were *orthoclase* and *lepidomelane* (?)

I obtained—

Silica	63·000
Alumina	3·051
Ferric Oxide	1·674
Ferrous Oxide	1·457
Manganous Oxide	·692
Lime	1·291
Magnesia..	15·615
Potash	·630
Soda	·794
Water	11·700
	99·904

Loses 6·365 per cent of the water, at 212°.

There can be little doubt that there is free silica here;—though the owder was sifted through fine linen, to ensure uniformity. I can offer o opinion as to what the unmixed substance is. Possibly it may be of ue nature of *cimolite* or *sepiolite*.

A Peculiar Copper Ore from Coombing Copper Mine, Carcoar, New South Wales.

By A. Liversidge, Ass. R. Sch. Mines, Professor of Geology and Mineralogy in the University of Sydney.

Read September 2nd, 1881.

A dark-grey, almost black, copper bearing mineral, somewhat resembling Redruthite in general appearance, but of a duller lustre and considerably harder; the hardness being between 5 and 6. In parts a bronze tint and lustre is apparent. The specimen exhibits neither crystals nor crystalline structure, it breaks with a well marked conchoidal fracture. Lustre somewhat resinous; streak shining.

Heated in a glass tube it gives off water, having a strongly marked acid reaction, from the sulphurous acid which is evolved. Before the blowpipe it does not fuse, colours the flame green, and acquires a dull black colour. Treated with strong boiling nitric acid it is rapidly acted upon, a bronze coloured residue being left, the residue when examined under the microscope presents a honey-combed appearance; the walls of the irregular cellular cavities are pale-brown and translucent and apparently composed of quartz; when the powdered mineral is boiled with nitric acid, a white residue of silica is left. Concentrated hydrochloric acid also dissolves out the copper, etc., but much more slowly.

The mineral is intimately associated with quartz, both ordinary white vein quartz and a translucent variety of greyish tint; this grey tint seems to be due to diffused very finely divided copper subsulphide.

The specific gravity of a portion quite free from visible quartz was found to be 3·12 at 18°C.

The following analysis was made upon a portion which appeared to be perfectly homogeneous even under a one-inch objective, yet this yielded over 43 % of silica.

Analysis.

Water, combined	2·354
Silica	43·420
Copper subsulphide (Cu_2S)	45·196
Iron Sulphide (FeS)	4·931
,, Sesquioxide	3·479
Undetermined and loss	·620
	100·000

The combined water was determined directly by collecting and weighing it in a chloride of calcium tube, a layer of lead oxide being placed in the front part of the combustion tube to arrest any sulphur or sulphur oxides.

The amount of silica soluble in a boiling solution of sodium carbonate was also determined in two other specimens.

	I.	II.
Soluble silica	14·69	19·99
Insoluble	22·13	14·81
Total silica ..	36·82	34·80

The mineral therefore appears to be merely an intimate mixture of amorphous and crystalline quartz, with copper subsulphide and more or less iron combined with oxygen and sulphur.

III.—*On the occurrence of Linarite in Slag.*

By Patrick Dudgeon, Esq., Cargen, Dumfries.

Read September 2nd, 1881.

WITH reference to Mr. Terrill's notice of "Crystallized products found in smelting operations" (Min. Mag. No. 19, p. 133) it may be interesting to notice the occurrence of Linarite in the cavities of the slag from an ancient lead smelting place in this neighbourhood. There are several ancient smelting places in the district where both lead and iron have been smelted, from the remnant of pottery found at the places they are evidently of Roman origin; there are no written records whatever of smelting operations having been carried on in this district, and it is difficult to conjecture where the ores smelted came from, the nearest known lead viens being 40 miles distant, and although insignificant veins of hematite occur in the neighbourhood, it seems impossible that sufficient quantities of the ore could have been collected in the vicinity to account for the very considerable heaps of iron slag found in two or three places. On examining one of the lead smelting places, on the farm of Martingarth, parish of Troqueer, I broke up some of the slag, and in some of the cavities found well-formed crystals of Linarite: the crystals are small, not above from 2 to 3 mm. in length, but perfectly defined and unmistakeable it is most probable that the mineral has gradually crystallized in its cavities during the long period the slag has been exposed to the atmosphere, and not that it was formed during the process of smelting. I found no other crystallized minerals in the cavities.

The process of smelting appears to have been very imperfectly carried on, many pieces of unreduced galena and globules of lead being found in the slag.

IV.—*On some Artificial Forms of Silica, illustrative of the structure of Agates, Chalcedonies, &c.*

By J. I'Anson, F.G.S., and E. A. Pankhurst.

(*Read September 2nd*, 1881).

It is a common chemical fact, that when a solution containing an alkaline silicate is acted upon by any reagent capable of separating the silica from the base, the silica is in the majority of cases thrown down in a solid form. The fact of this reaction is all that, as a rule, the chemist would look at: but in addition to the mere chemical fact of the precipitation of the silica, another most important element from the mineralogist's point of view is that of the *form* in which this precipitate of solid matter appears. This form naturally varies with the various conditions of the experiment, and it is by the study of these varying forms that the authors have sought to elucidate, experimentally, the wondrous and beautiful varieties of structure which are so familiar to us in the endless forms of silica occurring in nature.

The infinite variety in the great group of banded agates falls readily into two types. The *first* in which the solidification appears to have taken place in successive layers from within *outwards*; and the *second*, in which the impression is conveyed that the order of growth has been from without *inwards*.

In both cases, beyond the successive bandings there is very frequently observed a crystalline mass of silica, which does not present the banded structure.

In the first class this crystalline mass is to the *outside* of the banded part; in the second, it is towards the *inside*, as though there had been a central cavity within the bands which had become filled with crystalline unbanded silica.

Assuming, for the convenience of nomenclature, that these two types are the results of the two methods of growth indicated—a view we hope to justify in the course of this paper—we may name these the *exogenous* and *endogenous* types respectively.

With the exogenous type of agate are grouped such stalactitic forms of silica as show in transverse section a series of concentric rings or bands: and a careful examination of cut stones of this class

will shew the extreme frequency of the occurrence of these stalactitic forms in agate structure, more especially when such structure is intimately examined in microscopic sections. The last layers of a portion shewing exogenous growth frequently become the first of an adjoining portion, whose growth structure falls under the endogenous type.

The unbanded and mossy types, occurring in such stones as jaspers and moss-agates, form a separate group, of which we shall have something to say further on.

Let us now first take the *exogenous* or stalactitic type, and seek by experiment to elucidate its genesis and structure.

We may get stalactitic forms of silica by taking a solution of silicate of potash or soda, and dropping into it; or allowing to run down the sides of the containing vessel, any of the strong acids; but in order to get the best results and to produce the beautiful branching coral-like forms, our mode of procedure is as follows.

A strong solution of silicate is taken containing a certain amount of alkaline carbonate, and a strong acid (sulphuric seems to give the best results) is introduced by means of a pipette to the bottom of the vessel in which the solution is contained.

Bubbles of carbonic acid gas immediately arise, carrying with them a certain amount of the stronger acid. Round the stream of ascending bubbles, silica is deposited by the decomposition of the alkaline silicate, and in a very few minutes a tube is formed reaching from the bottom to the surface of the solution.

This tube is at first very thin, and through its walls the ascending acid continues to act upon the surrounding silicate, the walls of the tube in consequence constantly growing in thickness by the deposition of additional silica on its outer surface. As long as the flow of acid is kept up, so long does the tube grow in diameter by the deposit of successive layers, and the result is a hollow stalactite ringed in cross section.*

The carbonic acid evolved from the carbonate in the solution is essential to the successful commencement of the tube, but when this is once formed, the sulphuric or other acid can be itself forced through it, and by the application of pressure to the surface of the fluid in the pipette, the action can be kept up for a long time, and stalactites of $\frac{3}{4}$ inch in diameter can be formed with little difficulty. The same result can be produced by passing an acid gas, or even air highly

* Plate 1, Fig. 1. shews a group of such stalactitic growths of silica. At A and B these have come in contact with the sides of the containing vessel, and have thus been made, as it were, in section, shewing their hollow nature.

charged with an acid, through the alkaline silicate solution, and it will easily be seen that analogous effects can be produced by the action of any other reagents capable of separating the silica, such as acid salts of various metals. In fact the process can be varied in a hundred different ways. In natural siliceous stones where stalactitic forms enter into the structure, we constantly observe a central core, frequently of iron or other oxide, which appears to represent the original tube which has subsequently been filled up, whilst sometimes the cavity remains more or less completely as such. These stalactites of course do not grow up by any means in constantly straight regular forms, but assume irregular and branched ones, more like those of coral than anything else, according to the direction in which the bubbles of gas or the acid escapes from the end, or from points of least resistance in the sides, of the tube. Glauber's "Iron tree" is one form of this stalactitic growth.

The specific gravity of the fluid in which the stalactites are made, as compared with those of the reagent employed and of the precipitated silica, has of course much to do with the form assumed. Where these are equal, the tubes may take indifferently any direction with regard to gravity—and this is precisely what we find in nature, where it sometimes appears as if gravity had not had much to do with the directions assumed.

We consider then that the stalactitic productions thus made are the analogues of all the group of banded stalactitic growths which enter so largely into the constitution of many siliceous stones, where the growth appears to have proceeded from a central cavity, now frequently only a core, by reason of subsequent filling in.

If the action is carried so far that the surrounding fluid becomes saturated with acid reagent, the whole of this surrounding fluid gelatinizes by the precipitation of amorphous gelatinous silica, and if we suppose a case in which such stalactitic forms have been produced in nature in an enclosed rock cavity containing an alkaline silicate solution, by the infiltration of an acid solution, a like result would occur. In point of fact, as we have already stated, such natural forms constantly occur with a surrounding mass of crystallized unbanded silica, and this we are led by many observations to regard as the analogue in nature of the gelatinous silica resulting from the saturation of the fluid in which the stalactites have been formed. Whether in nature this crystalline silica has been originally deposited in a gelatinous form, and subsequently crystallised, is a little out of the scope of this paper: but analogy leads us to regard this as most probable.

II. We come now to the question of the formation of banded agates of what we have called the *endogenous* type; which are in reality, so to speak, the converse of the type of structure which we have just been considering.

Assuming hypothetically a rock cavity containing a solution of alkaline silicate, and the rock in which this cavity is situated permeated with an acid solution or gas, we should naturally expect to find a layer of silica deposited on the walls of such a cavity, and as the action continued more and more silica would be deposited; and if the solution were *enclosed* in the rock cavity, the central portion would, when the action had continued to a certain point, set in an amorphous mass.

This action is very completely parallelled in some of the preparations which we have made, and in some of these we have found that a central vacant space was left, owing to there not being enough silica in the solution to fill the whole cavity when precipitated in the gelatinous form. This is precisely what occurs in many natural agates, where we find a deposit of crystalline unbanded silica within the banded portion, with a vacant space in the centre of all.

We have, so far, dealt only with the production of these various forms in more or less pure silica: but by the use of acid solutions containing various metallic and earthy salts, we can imitate, to a great extent, the colouring of natural stones. More especially is this the case in the next group with which we have to deal.

Jaspers, Moss-agates, &c. The varieties of structure of the class of stones roughly grouped as above, are exceedingly interesting and beautiful. The way in which the various colouring matters are arranged, suggests at once the idea of *chemical precipitates*, and although, perhaps, the different types of structure are not so strongly marked as in those groups with which we have already dealt, yet there is much of interest in their elucidation.

Perhaps the most prevalent colouring matters in this class of stone are the red and yellow ferric and the green ferrous oxides. Both these classes may be readily imitated by introducing into alkaline silicates various ferric and ferrous salts. If an acid solution of a ferric salt—for instance ferric chloride—be so introduced, we find, first, a more or less flocculent precipitate coloured red or yellowish; and subsequently, as the action goes on, around this grows a filmy white deposit of silica, which frequently falls into banded forms, precisely analogous to constantly recurring markings in jaspers and allied stones. With ferrous salts, again, the green mossy markings of the moss-agate and the darker colour of the onyx can be perfectly produced.

Many interesting forms can be obtained by allowing stalactitic forms to come in contact, as they grow, with the sides of the containing vessel, by which means they may be made, as it were, in section, and the progress of their growth readily and conveniently watched. By combinations of these methods, a vessel may be entirely filled up with different forms of structure and colouring, presenting a very close resemblance to the natural products whose genesis it is sought to illustrate.*

It would be impossible within the compass of a paper of any reasonable length to go into all the variety of solutions and reagents with which we have worked, or to give all the special coincidences with natural form and structure which we have observed; but the following brief notes of some such special points may be of interest.

Horizontal banding is frequently met with in natural agates, and we have found it very completely reproduced in many of our preparations.

Some alkaline silicate was poured into a dilute solution of silicate of soda, which had been previously acidulated with dilute hydrochloric acid. A jelly was at once formed, enclosing in a species of cavity a portion of the alkaline solution. Into this the hydrochloric acid, together with the chloride of sodium resulting from the decomposition of the silicate, exuded from the gelatinous mass, and a series of horizontal bands extending across the cavity gradually formed.†

A solution of commercial alkaline silicate, particularly silicate of soda, is capable of dissolving considerable quantities both of pure gelatinous silica, and also of various silicates, such as those formed by precipitation with sulphates of copper and iron, as well as those of the alkaline earths.

In watching the growth of these stalactitic accretions in section on the sides of the containing vessel, the production of the bands has been observed to vary with different conditions of—1st, temperature, 2nd, acidity of precipitating solutions, 3rd, pressure.

If a solution of ferric sulphate, ferric chloride, or cupric sulphate, be poured into an alkaline silicate, coloured precipitates result, which, when washed, we have dissolved in alkaline silicates, producing the

* Plate II shews two examples of this. In both preparations the growth has commenced by stalactitic forms coming in contact with the sides of the containing vessel, and by continuing the action these have developed a series of successive bands external to the original tubes. The space beyond these bands consists of almost structureless silica due to the ultimate saturation of the alkaline silicate with the acid reagent.

† Plate III, fig. 1.

purplish red and green solutions exhibited, by the use of which in our preparations we have found the various colours of natural stones very closely imitated.

Hair-like Enclosures in Silica.—To produce the specimens figured in Plate III, fig. 2, the following process was adopted. A solution of silicate of soda, containing carbonate of soda, was taken; at the bottom of the vessel small fragments of acid salts, such as ferrous and ferric sulphates, were placed. The action of these on the carbonate in the solution gave rise to very minute bubbles. These ascending through the solution were followed by others, till a tube was formed reaching often to the top of the alkaline liquid. In the reaction between the iron salt and the solution, the tube became filled with a ferruginous liquid, and thereby coloured red, brown, or black, according to the substances employed.

So-called "Orifices of Inlet."—When the continuity of the bands is interrupted by the escape from within the cavity which they surround of the contained acid solution or gas, an appearance results closely resembling the so-called "Orifices of Inlet" in natural agates. The bands are bent outwards and thinned away at their interrupted ends, and at times the space between them is filled with a tubular stalactitic form, as shewn in Plate 1, fig. 2. Our observations and experiments enable us fully to confirm the view of those who hold that these so-called "Orifices of Inlet" are in reality more or less complete efforts to form outlets.

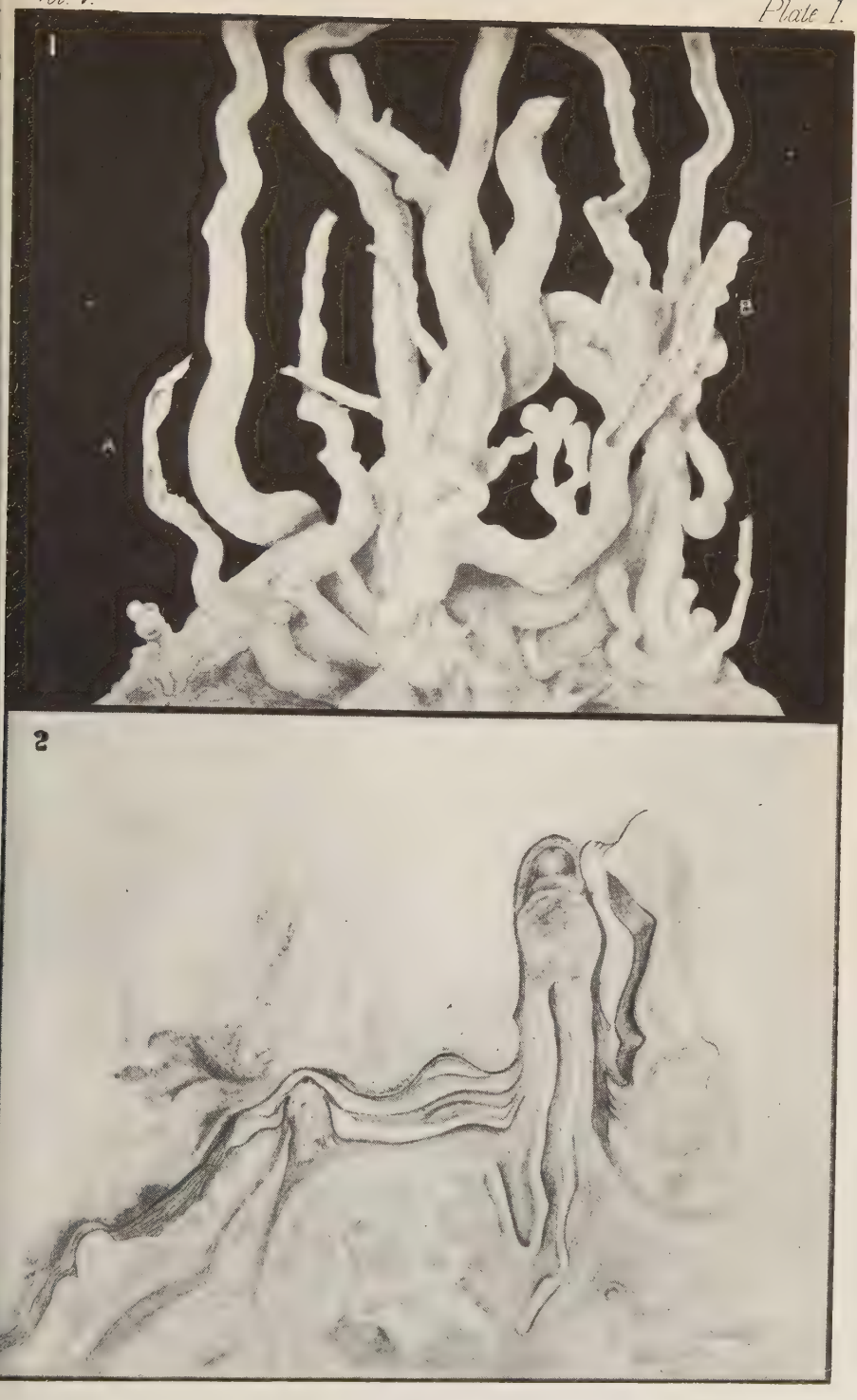
The precipitated silica in these preparations, being deposited at no great pressure or temperature, of course falls far short of a perfect reproduction of the natural stone in point of hardness and stability. Exposed to the air they, for the most part, dry up and crumble away, although we have produced some forms which approximate closely to common opal in appearance, though of lower specific gravity, and these remain with little or no alteration after once being dried. It is only in form and structure that we can as yet claim to produce any imitation of nature's products: but it is conceivable that under suitable conditions of heat and pressure closer imitations might be made.

How far in nature the assumption of a crystalline structure may have taken place subsequently to the original solidification, is a question upon which, so far, we can only speculate; but we think it is probable that this may, to a great extent, have been the case. We do not touch upon this point in other than a tentative sense, in the hopes of eliciting from others any evidence which they may be able to offer on the point.

In conclusion, we have to acknowledge our indebtedness to Messrs. Gossage, of Widnes, for very kindly and generously placing at our disposal the material necessary for these experiments.

Mr. Wm. Lant Carpenter (B.A.,B.Sc.,F.C.S.) as a visitor, but as a late manufacturer of silicate of soda, begged to congratulate the authors upon their very admirable paper, and to offer two remarks thereon. The authors had been unable to obtain specimens of precipitated silica possessing any degree of hardness, most of them drying up and crumbling. About 15 years ago he had had occasion to prepare, on a large scale, great quantities of precipitated hydrated silica, by decomposing solutions of sodium silicate (sp. gr. 1·250) at 230° Fah. with excess of hydrochloric acid. In the tank, underneath the gelatinous silica, when cleared out after 4 or 5 operations, was a layer of *extremely hard* silica, which required a very sharp steel pointed pick for its extraction. This had a fracture very like that of flint, and he had kept it till the present time without any diminution of hardness; it would not quite scratch glass, but was intensely hard. He had never published the observation.

The other point related to the concentric veins seen in the natural agate, and in those now shown. Just as albumen when coagulating in a fluid attracted to itself minute suspended particles (hence its use in clarifying sugar solutions), so colloid silica at the moment of its liberation in the nascent state, as it were, attracted to itself minute suspended particles, and it was in this way, he conceived, that these concentric veins or markings were formed from the mechanical impurities present in the solution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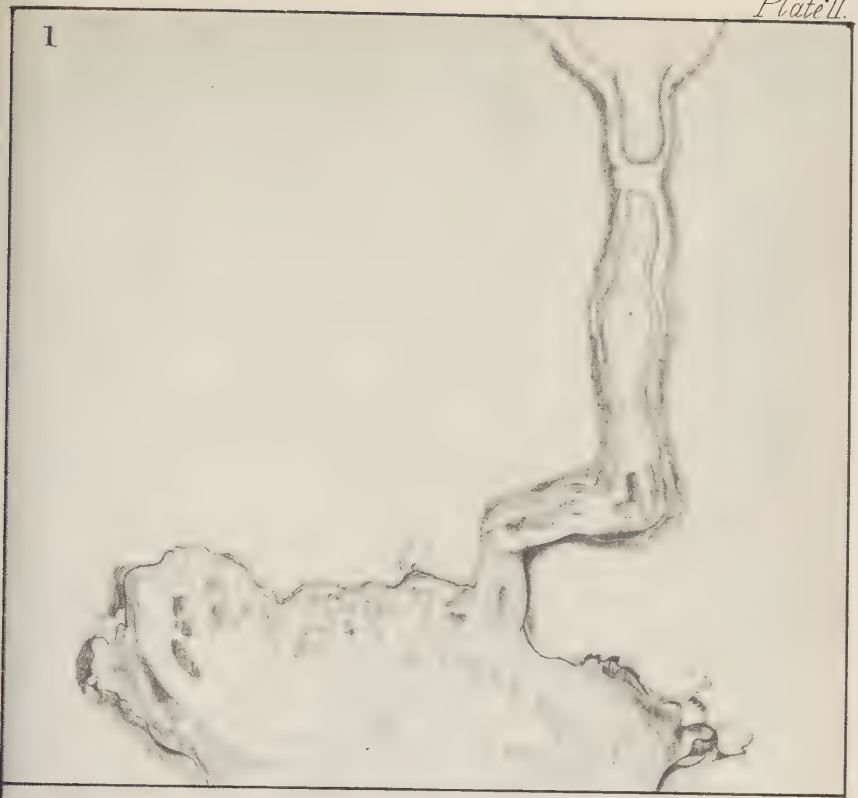

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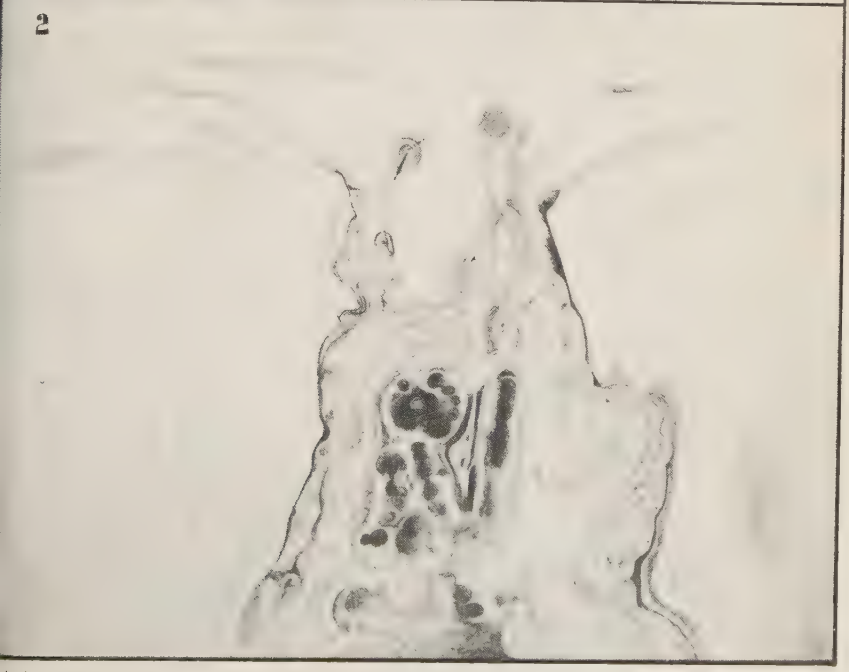

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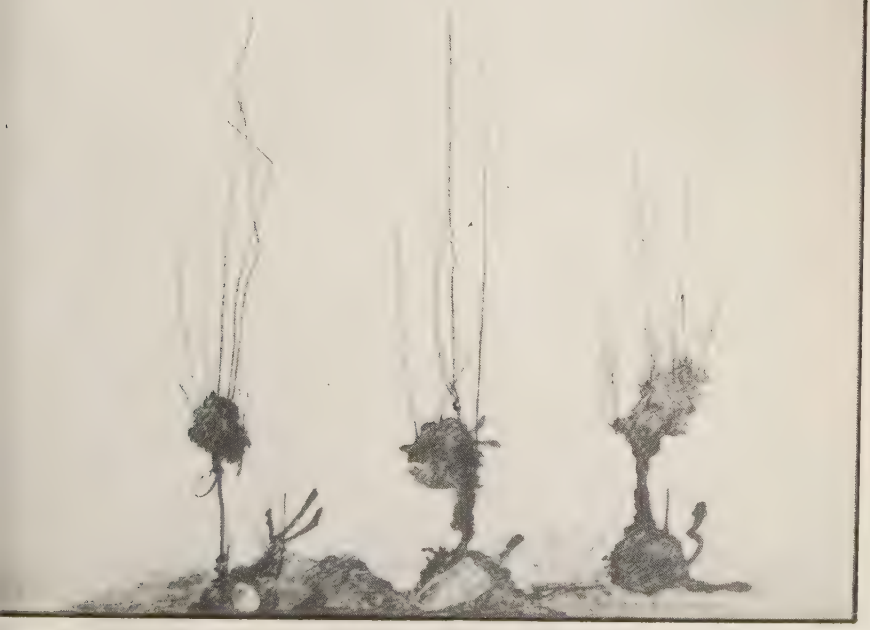

DESCRIPTION

OF THE

GEOLOGICAL MAP OF SUTHERLAND.

By Professor Heddle.

IT was with considerable reluctance that I felt myself compelled to discard the system of coloration adopted in the Geological Survey Maps; and this I did only after the strongly expressed opinion of several geologists.

It was not that I have any very intense desire to colour rocks after their natural tints, but I have an aversion to adopting a colour suite which departs markedly therefrom; or one which is in discordance instead of harmony therewith. One friend, a man of great scientific discretion, and himself an artist, writes me that when he looks at a recently published geological Map of Scotland, with its grey Torridon and its red Laurentian, he does not know whether he is standing on his head or his heels. I must say that I share the feeling intended to be therein expressed; and hold that, if there is to be an absolute departure from the tone presented by the rocks themselves, we, at least, should not have the incongruity of a bed of a sombre or dark hue, reposing upon one of a markedly lighter tint.

The colours, then, which have been adopted, if they differ from such as were formerly in use, have been selected upon the foregoing principles; namely, some resemblance to nature, and the keeping the graver tints for the more profound rocks.

There is what may be considered a departure from this, in the case of the lively tint given to the so-called "igneous rock." As this rock much resembles in many ways the Hebridian gneiss,—being only of a lighter tint,—a green was also chosen for it. While it may be urged that there is here too marked a distinction between it and the quartzite series to which it belongs, it has to be stated that a pronounced and brilliant colour was chosen, (to, perhaps, the detriment of the map as a whole,) in order that attention might be drawn in a forcible manner to *the* rock which the writer maintains will prove to be the key to the reading of the much-contested geology of the district.

In proceeding to direct attention to some of the features of the map, and to the facts which it evidences, the author has in the outset to state, that for all the lines laid down on the eastern side of the county, he is indebted to Dr. Joass, and to Professor Judd. To the first for much information imparted both by word of mouth and by letter;—to the latter for what is in fact almost a pantographed transcript of his published map of this eastern district.

The Old Red Conglomerate which caps the summit of Ben Armine, was inserted upon the authority of Mr. Crawford, of Tongue.

The author is responsible for almost every line of the rest of the map, (some few errors being corrected). It may be that certain of the lines are much the same as those which have appeared in former maps, especially in that of Cunningham;—if so, they have been verified.

The following are the points or localities which he has not verified, or has inserted chiefly on information derived from others.

The whole line of junction of the Torridon of the Rhu Storr with the Hebridian gneiss, is taken from Macculloch. The occurrence and the exact site of the upper limestone at Fier Loch Karstich, and at Loch Strathnashvish. The former he could not see from a height at a distance of a mile; the greenery of the latter he did see at the spot laid down, from the slopes of Ben Leod.

The position of the dolomite (and whether it was touched by the igneous rock) at the back of Craig Dionard.

The lines of junction of the upper quartzite with the "igneous rock" and with the upper gneiss, were not *walked along* between Loch More and the slopes of Ben Leod; though they were *seen* in their higher rolls from the summit of that hill;—and *portions* of the line of junction of the upper gneiss were not walked along at the back of Ben Uidh, and eastern Ben More; as also at the hill Arkle.

Every other line of junction was either walked along, or was so immediately under the eye of the writer, that he is, in all localities of importance at least, prepared to submit them as being nearly absolutely accurate.

As the amount of confidence which is to be placed in a geological map must in a great degree depend upon the extent of ground walked over,—and, as there is no better way in which to submit this than by enumerating the hills climbed, there is subjoined a list of the hills with their heights, which the writer ascended between Loch Torridon and the north shore. The whole of that district he explored with nearly equal care, before he considered that a sufficiency of data had been collected to entitle him to assume an assurance of expression equivalent to that which has been assumed by others.

Torridon, Dundonnel, and Kinlochewe Districts.

	feet.
eagach, south top	3358
en Eay,—whole ridge	3220
ioun Bheinu	3060
enin a Mhuinidh	2267
ioch	3260
gurr an Tuill Bhan	3058
'Mhaighdean	2995
enin Tharsiunn	2965
ullach Coire Mhic Fhearchair ...	3300
gurr Dubh	2950
eallan Laoch	1950
ail Liath...	2982
orray Buidh	3041
curr Fiona	3474
lass Meall Liath	3082
idein, a Ghlas Thuil	3483
las Meall Mhor	3176
al Mhor	2538
einn Dearg	3547
einn Aonachlair	2915
	60621

Coigach and Assynt District.

	feet.
einn Eiledeach	1755
en More, Coignach ; east top ...	2265
oul Beg	2525
tack Polly	2009
oul More	2786
romalt Hill	1265
noc na Glas Choille	1008
noc na Meallain	1225
noc na Stroine...	1306
noc Ledbeg	1200
noc an Leathaid Bhuidhe	1205
ræbag	2670
en a Bhrachaidh	2334
ræbag Tarsuinn	2338
einn nan Cnaimsheag	1740
unisp	2779
uilven	2399
gonnan Beg	1240
eall a Bhuridh...	1380
arn nan Conbhairean	3190
en More...	3273
oineveall	3234
Na Tuadhain	2824
Ben Uarran	2644
Mullach an Leathard Riabbaich ...	2410
Beinn Uidh	2384
Cnoc an Drian	1560
Glas Bheinn	2541
Cnoc na Craige	1745
Quinaig	2653
Stack of Glen Coul	1740
Rhi Chnoc	1730
Beinn Leod	2597
Meallan a Chuail	2461
	72445

Reay Forest, and the North.

	feet.
Ben Hee	2864
Carn an Tionail	2484
Carn Dearg	2613
Meallan Liath Coire Mhic Dhughaill	2625
Meallan a Loin	2483
Meall Garbh	2471
Benin Laoghal	2504
Benin Heil	1780
Meall Leathad na Cnaoibhe ...	1018
Beinn Bhreac	1020
Cnoc an Fhreicadain	1009
Ben Hope...	3040
Ben Strome	1543
Ben Stack	2364
Handa Island	406
Foinaven	2996
Cnoc Poll a Mhurain	503
Cnoc a Gheodha Ruadh	598
Sithean na h'Iolaire	758
Diman Mor	523
Clo Mor	630
Meall Sgribhinn	1216
Crann Stacach	2630
Beinn Spionnaidh	2537
Cnoc ard an Tionail	603
Creag Mheirgeach	746
	43954
	60621
	72445
	177020

The grounds upon which I base the sequence of rocks, which I elieve to be the true one in this county, will be submitted elsewhere,* describing *eighteen sections*, drawn between Kinlochewe and Loch len Coul. I must content myself at present with a few brief remarks pon the rock, which, from its having been generally designed as such, have in the map termed the "igneous rock," of the quartzite.

This rock I find to occupy an unvarying position.

When it appears as a single bed, that position is immediately over the olomite. When more beds than this one appear, they are as invariably be found intercalated in the upper quartzite.

This rock has given rise to an almost endless amount of controversy; amount which the writer is satisfied would have been minimised, id only the twentieth part of the time been devoted to observation

* Transactions of the Royal Society of Edinburgh.

of it in the field, that has been frittered away in discussing it, upon al too narrow grounds;—indeed in many cases from an examination of it at but a single locality.

According to some of the writers and disputants who have treated o this rock, it has broken through at various horizons, the junction rocks, along the whole line of strike from Whitten Head to Loch Maree (indeed, according to one, as far south as Totaig on Loch Ailsh).

According to others, it only *appears* to have broken through these rocks; having in reality been so positioned through faulting. While, according to others, it is held to be conformably bedded with the other members of the higher formation.

We also find that petrologically it is, according to

Cunningham ...	Upper Gneiss.
Nichol ... Murchison Harkness... Hicks ...	Intrusive.
Geikie	Upper Gneiss, metamorphosed in situ, from the near presence of lime.
Hudleston ...	Old Gneiss, faulted up, and partly invaded by extravasated matter.
Bonney	Old Gneiss, faulted up, its upper portions crushed, especially when near lime; and sometimes granitoid from predominance of felspar.

Of the above writers, Cunningham, Geikie, and Bonney, recognise or admit conglomeritic or brecciated structure, in this rock; while Nicol, Murchison, and Hicks, do not recognise, or overlook this.

Again Cunningham, Geikie, and Bonney vouch for a laminated structure, and a rude bedding, as being "sometimes to be seen," or "apparent"; while Murchison and Hicks do not recognise this, and Nicol very seldom does.

Cunningham, Harkness, Ramsay, Geikie, and Murchison, hold that it does not "break up" the upward succession of the rocks; Nicol, Bonney, Hudleston, Hicks, and lately Callaway maintain that it does.

In presence of so great a turmoil of opinion as the above, is it any wonder that Mr. Hudleston, in a most successful endeavour to "act the part of an impartial historian," should write—"Dr. Hicks, like all previous authors, is not a little troubled by the "igneous rocks,"—or that he should admit that he himself was "in a fearful fog as regards the merits of the whole controversy,"—and that the summing up of his critical sketch should be the finding, and there "was room for further examination."

Sir Rhoderick Murchison writes:—"it in no way hinders the observer from developing a clear and conformable order of superposition." The present writer goes a great deal further than this, and maintains, that

while there are many sections where a clear order of superposition is developed without any material aid from this rock,—indeed, where it is not even present,—that still, in the more disturbed districts there is little hope of unravelling the *apparent* confusion which exists, without bringing in the aid which a thorough knowledge of the position or positions of this rock can afford.

Of the above authors, Cunningham, Nicol, Murchison, and Geikie, refer to the rock or rocks, as seen at several localities; the others at but few, or even at but one, and that one the locality where, perhaps of all others, it assumes the extreme of one of its appearances.

Had these authors walked along the strike of this rock—best at its lowest edge—picking up the dolomite along that strike, invariably in the same relative position, *one* if not all of the points at issue would have been rapidly resolved into a common stand-point of agreement.

As to the precise nature of the rock,—this has been pronounced upon by some of the more recent writers (after an amount of exploitation which their descriptions show to have had the proportions of a post-prandial saunter) with an amount of assurance which the present writer feels that even an extent of walking very inadequately vouched for by one hundred and seventy seven thousand feet of climbing, *does not entitle him to assume*. He would beg leave to refer to his paper before mentioned for his views; merely stating here that his opinion coincides with that of Cunningham and Geikie.

And he would submit the following facts, in controversion of the *two* views that it is the older gneiss,—and that it is an *eruptive* igneous rock.

First.—The invariability of its position throughout a stretch of over seventy miles; always *over* the dolomite, and if there be more beds than one *in* the upper quartzite; if there be only one bed, it underlies the upper quartzite, where present; the upper gneiss, where not present.

Second.—That along the whole line, at least from Loch Maree to Whitten Head, it at no spot shows a neck, or point of outflow.

Third.—That where it occurs in the upper quartzite, in five closely adjacent beds at Cama Loch, these beds never run into one another, or branch, tothe smallest extent.

Fourth.—That where it is seen in highly-faulted localities, as at the east end of Mullach an Leathaid Riabhaich and elsewhere, it is never seen entering the rents, itself; but occurs in its proper place, as a layer or bed in the dislodged fragments.

Each of the above facts would throw doubt upon this being an eruptive igneous rock; taken collectively their evidence to such an effect could hardly be more complete.

There is, however, another fact connected with this rock, which has much significance. It is, that, apart from the constituents special to it, it contains *no* minerals. Imbedded crystals—druses—and veins, are alike unknown to it. Can a barreness of such a nature be shown to occur in an eruptive igneous rock of equal bulk, elsewhere?

This feature also serves to distingnish it from the lower gneiss, which many contains accessory minerals.

The sequence of rocks, which the writer holds to exist in Sutherland, is as follows :—

Hornblendic Gneiss	High dip to W.S.W. and S.W.
Conglomerates; small in grain, much attrited, no limestone fragments	Along west shore dipping at 5° to 7° to W., or W. by N. Ten miles inland, dipping 5° to 7° E. by S.
Quartzite; with intercalated large-crystalline porphyry, and rarely fine grained beds ...	Overlying *eastern* portion of the conglomerate only; with dip to S.E., ... to 30°.
Yellow flaggy argillaceous beds	Conformable.
Fucoid beds	Do.
Dolomite; with occasionally yellow quartzite layers, and a band of "trap" ...	Do.
Fissile chloritic beds	Do.
"Igneous rock;" sometimes cut vertically by dykes of dark-green "trap" ...	Do.
Upper Quartzite; containing sometimes four intercalated beds of the "igneous rock;" and an albitic porphyry, which sometimes cuts it in thin dykes, and sometimes is intercalated. ...	Do.
Limestone; of from two to several beds, separated by beds of flinty quartz-rock ...	Do.
Beds of Quartz-rock, resembling "hornstone"	Do.
Gneiss of very varying features; sometimes plicated "chloritic;"—sometimes flaggy micaceous;—sometimes hornblendic, crystalline, ...	Do. but a few miles to the east, the dip in the north of the county, swings round to the north; while in the south, it swings round to the south.
Breccia; very angular, large in grain, with limestone fragments	Unconformable; dip in the north, 5° to 15°, N. by E.
Conglomerates, not smoothly attrited ...	Conformable.

It is about forty-five years since one of the most conscientious and hard working of Scottish geologists told us that, in Sutherland, one gneiss was overlaid by conglomerates unconformably; that, in turn, by quartz-rock, also unconformably; that, by a sequence of limestone,—quartz-rock—a second limestone,—with a second gneiss, all conformable with one another. The same geologist described the "igneous rock," as a mere variety of the second gneiss.

The sequence now given, *is merely this old sequence*, stated in more detail. Chemistry has told us that the *first* limestone is Dolomite; and new traverses,—perhaps still more extended than those which the enthusiastic Cunningham was able to undertake,—rendered practicable through the open-handed hospitality *of a whole county*, at the behest of its noble proprietor,—enable the writer to state that the rock which Cunningham described as a mere variety of the upper gneiss, is to be regarded as such, and nothing else; if we are to be guided in our conclusions by such facts *as* its occurring among beds of rock which are conformable with that upper gneiss; *and as* its differing from the ordinary appearance of that gneiss to no whit a greater degree than do the beds of that rock itself which occur at the Whitten Head, and over the whole tract of ground which lies between Tongue and Farr.

The following errors have crept into the map.

At one or two points the colour of the upper gneiss has been swept too far westward; it has thus broken the continuity of the quartzite band; as between Foinaven and Arkle, and between Arkle and Loch More. At one or two points it has covered over ground intended to be left *uncoloured*, on account of its being concealed by swaddling and swarding.

The fault at Knockan, and the quartzite tip on Suilven, should be removed.

The fault at Loch Borrolan has to be removed southward, *a quarter of an inch*; so as come in the line, and under the influence of the marks of doubt;—it being a very-doubtful fault.

A mark of doubt has to be inserted at the *middle* of the Ben Uarran fault; as this probably dies out, about the glen between Coineveall and Ben Uarran.

The anticline is placed too far up the slope of Ben Uarran.

The fault which cuts the limestone of Smoo off from the quartzite, should not extend west, so as to intersect the faults which let-in the basset of upper gneiss. These faults of necessity must intersect to the south; but where is not known. The fault running from head of Loch Glen Coul (if it exists), dies out about two miles up the glen; and does not intersect the faults which bring up the great wedge of "igneous rock."

There are some trifling errors in detail, but none which are vital.

Had the writer acted upon theory, even to what might be regarded as legitimate extent, he would have connected the "igneous rock" of

Sconnan, with that of east Ben More. He saw it at some intermediate spots, like stepping-stones, the whole way across; but he did not walk over the ground, at the stream side; and therefore the green band was not made continuous.

Agreeing as he does with Nicol (and lately Callaway) as regards the dolomite of Stronchrubie lying in a basin, he does not agree with either, as to the inferences to be drawn therefrom. A great semi-circular, anticlinal-roll of the lower quartzite troughs the dolomite; which has thinned out before it plunges under the "igneous rock" of Ben Bhrachaid; but the *argillaceous beds* are there seen, dipping under the "igneous rock."

He also differs, altogether, from both of the above writers, as to the Cnoc-an-drian section; maintaining that the views of Murchison, Harkness, and Geikie as to it, are correct; though he cannot agree as to the *details* of the sections given by either Murchison, or by Harkness.

V.—*Note on Artificial crystals of "Specular Iron" formed in a Copper Works Slag.*

By W. TERRILL.

Read September 2nd, 1881.

SINCE my last communication on Artificial crystals (Min. Mag. No. 19), I have met with some very remarkable crystals formed in a Copper Works Slag which consisted mainly of Cuprous Oxide and Ferric Oxide with a little lime, a product from melting a charge of "copper precipitate."

The crystals are hexagonal plates, bounded on the edges by the faces of a rhombohedron which roughly measured gives an angle of R : R=86°. They are iron black in color, with a splendent metallic lustre, and contain 50% Ferric Oxide with 45% copper.

Examined under the microscope or even with a strong lens, particles of copper and cuprous oxide are visible in a separate state.

I am of opinion that these are artificial crystals of "Specular Iron," which have separated out on cooling from the molten slag, and crystallized in a sort of skeleton network, the interstices mechanically imprisoning the particles of copper and cuprous oxide which are present.

A small quantity of lime was added to the charge for the purpose of combining with and fluxing the Ferric Oxide; but no lime was found in the crystals.